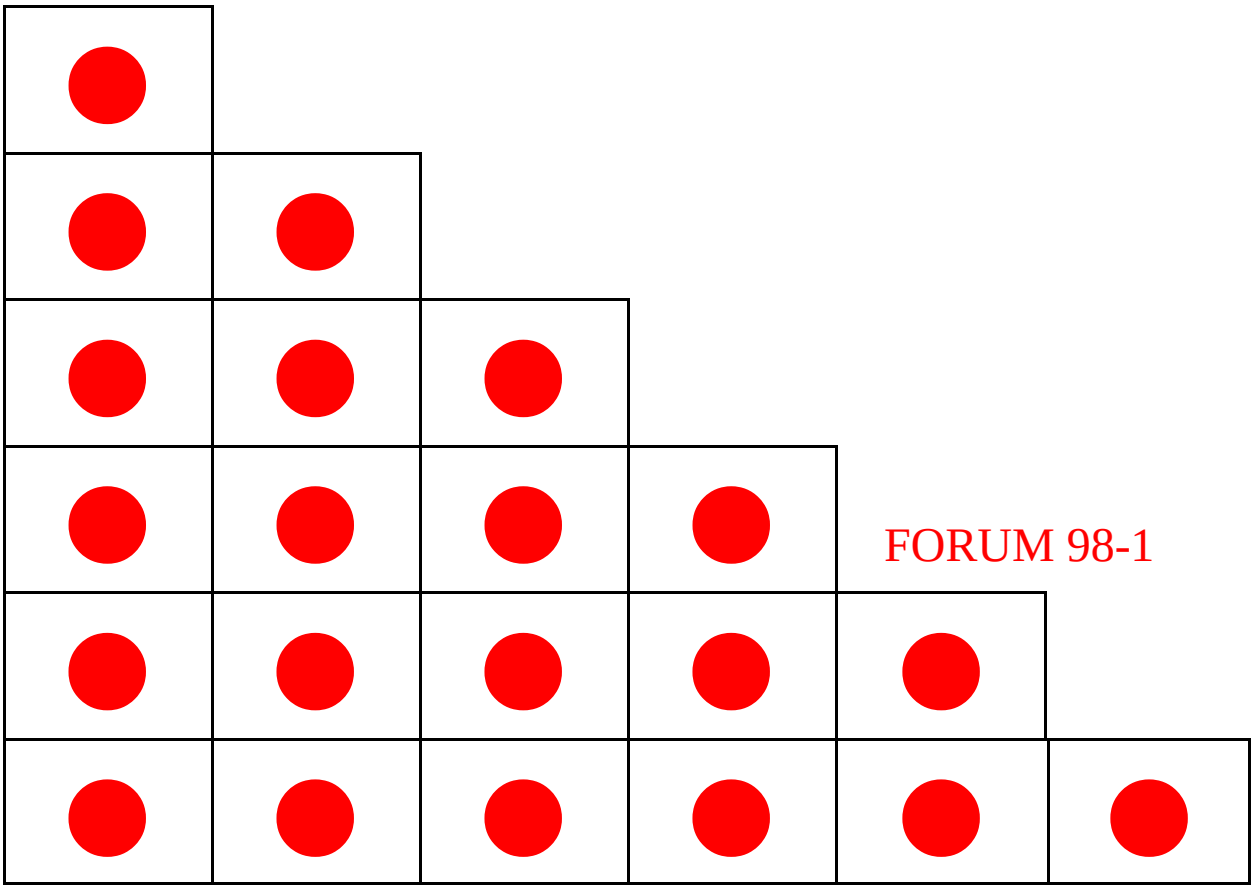
Comprehensive Fireproof Building Design Methods

A Translation of the Japanese Methodology for Building Fire Performance Evaluation under Article 38 of the Building Standard Law of Japan

Volume 1
Regulations for Comprehensive Design for Fire Prevention



FORUM 98-1

Comprehensive Fireproof Building Design Methods

Volume 1

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This document was translated from the original Japanese under auspices of the FORUM for International Cooperation on Fire Research and the National Institute of Standards and Technology's Building and Fire Research Laboratory in the USA. The translation was professionally done and minor editing was limited to correction of literal translations of technical terms to those more commonly used. Grammatical editing was not done in order to avoid unintentional distortion of intent. This translation was undertaken in order to make the contents available to the English speaking countries of the world. Permission for this translation was given by the copyright holder, the Architectural Center of japan, on the condition that it not be sold for profit.

On the Publication of Comprehensive Fireproof Building Design Methods

The goal of this book is to make available to a wide public the research results of the Development of Fireproof Building Design Methods of the Construction Ministry's Comprehensive Technological Development Project completed in 1986.

In recent years, buildings have become increasingly diverse and complex both in shape and in function. Amidst this environment, there has been a strong demand from various quarters for development of rational and comprehensive fireproof design methods which would create richer spaces and attain definite fireproof standards in combination with various building conditions. The Development of Fireproof Building Design Methods was promoted by a consortium of industry, academic and government groups to respond to this demand by turning the specification regulations relating to fire prevention in the current legislation to performance regulations insofar as possible. The National Land Development Technology Research Center and the Japan Architectural Center were commissioned by the Construction Ministry's Architectural Research Institute to carry out the research and received some assistance with the project. After five years of working on the development, the Construction Ministry has consolidated the research results.

Upon the suggestion of the Construction Ministry, a Comprehensive Fireproof Building Design Method Compilation Committee was set up at the National Land Development Technology Research Center to work on the design method and publicize the research results of this Development of Fireproof Building Design Methods. The results have been published in the form of Volume 4 Comprehensive Fireproof Building Design Methods by the Japan Architectural Center.

This work is made up of Volume 1, Comprehensive Fireproof Design Methods, Volume 2, Design Methods to Prevent Fire from Spreading, Volume 3, Evacuation Safety Design Methods and Volume 4, Fire-Resistant Design Methods. All of these have been consolidated to be used as a manual for persons working in the fireproof building design field and we hope that they will contribute to improved building technology.

Last of all, we would like to thank the many people who worked on the development of this project. We would especially like to thank Mr. Kishitani, the Committee Chairman and all the committee members for their hard work on the editing of this book.

April 1989

Tadashi Kosaka, Executive Director, National Land Development Technology Research Center

Mitsuhide Sawada, Executive Director, Japan Architectural Center

On the Editorial Supervision

In recent years, buildings characterized by new shapes, materials, building methods and functions such as intelligent buildings, membrane-structure buildings, large wooden structured buildings have been designed one after another. There has been a demand for increasingly sophisticated fire-prevention measures both for these diverse, complex buildings as well as for the conventional buildings. Nevertheless, until now, there have been no methods for appropriately evaluating the safety of these and for sufficiently reflecting this in designs. As a result, the actual design process had to be simply based on the regulations of the Building Standards Law and experience and it could hardly be called design which was based on an engineering approach.

It is the sincere hope of all those engaged in fire-prevention for buildings that fire-prevention safety for buildings can be evaluated in a more rational fashion and that these buildings can be designed more rationally from the viewpoint of fire-prevention safety. Therefore, they have been waiting for development of comprehensive fireproof design methods which can forecast the fire characteristics for building spaces for an external force such as fire and which can be used to evaluate these characteristics using the safety standards required.

Against the backdrop of the need for these fireproof design methods, the Construction Ministry carried out its Development of Fireproof Building Design Methods for five years starting in 1982 as one of its Comprehensive Technological Development Projects and has compiled the results. The Comprehensive Technological Development Project promotes comprehensive planned research and development under the auspices of a consortium of industrial, academic and government groups working closely together on research topics relating to building technology. These topics relate, in particular, to problems for which there is strong social pressure to resolve and to large-scale research topics which cover a wide spectrum of issues. As a result, these research results are widely used in a variety of sectors beginning with government construction administration. The fireproof design methods developed in this project can be used to carry out fireproof safety design which is easy to understand. We believe that they will be extremely useful for persons engaged in fireproof building safety design. These results have been published in the form of the Comprehensive Building Design Methods.

It is our hope that the book will be widely used by people in the fireproof building technology field and will contribute to the development of fireproof building technology in the future.

April, 1989

Nobuhiko Satoh
Head, Technology and Research Department, Construction Minister's Office

On the Publication of Comprehensive Fireproof Building Design Methods

Fire-prevention measures presently used implement fire-prevention standards for the parts of buildings and buildings are built in accordance with these. Methods of carrying out fire-prevention measures based on these fixed standards are relatively simple and we believe that they are effective for securing a certain degree of fire-prevention standards. However, in recent years, it has been difficult to achieve complete safety in designing buildings which have become more diverse and more complex and we have become burdened with a surfeit of measures.

In order to resolve these problems, designers must select the appropriate fire-prevention measures which fit the space conditions, functional conditions and other conditions of each individual building. Methods are required, that is, methods for fireproof design, which combine these and attain the fire-prevention standards as an architectural entity. Recently, there has been an increase in buildings which are built partially applying these concepts and with the approval of Article 38 of the Building Standards Law. However, in order to apply these fireproof design methods for even more buildings so that more rational fire-prevention measures can be carried out, there will be a need for a technology which appropriately forecasts and evaluates how fires in the buildings being designed will break out and spread, how the disaster-prevention devices will operate and how humans will behave during a fire.

This book focusses mainly on the Fire Research Section of the Architectural Research Institute and the results of its five-year Comprehensive Technology and Development Project in which it cooperated with a wide spectrum of persons from government, academia and the private sector. We believe that the book will be extremely effective as a research tool for persons who have fireproof design as their chief objective.

In promoting the project and in publishing this book, we would like to offer our sincere thanks to Professor Kunio Kawagoe and Professor Koichi Kishitani and the many researchers involved in the project for their guidance. We would also like to thank the National Land Development Technology Research Center, the Japan Architectural Center and the other institutions for their cooperation.

April 1989

Susumu Fujimatsu
Head, Architectural Research Institute, Construction Ministry

A Message

Until twenty-some years ago, phenomena relating to fire were like black magic. It was virtually impossible to scientifically forecast fires and to use engineering methods to carry out fireproof design based on such forecasting methods. Nevertheless, as research on fire has progressed and as science has thrown new light on fires, there has been greater confidence that this is indeed not impossible. Along with this, there has been increased recognition that there is a need for rationalizing fireproof design for buildings and to systematize the engineering technology needed to carry it out. There has also been a rapid increase in the awareness of this approach globally and a great deal of research has been carried out to bring this into practical use.

It is against such a background that the Construction Ministry has engaged more than 240 leading researchers, designers and administrative officials to carry out the development of Fireproof Building Design Methods in the Comprehensive Technological Development Project. The purpose of this effort was to make a compendium of all previous fire-prevention research and to develop rational and comprehensive fireproof design methods based on a scientific foundation. The invaluable results of this effort have been brought together and published here. These design methods go beyond the specification-type regulations found in current legislation and aim to obtain an even greater degree of safety using methods which allow for greater cost-effectiveness and greater freedom. This book is invaluable as a manual not only for architectural engineers engaged in this type of design but for government officials and researchers involved in related fields as well. It should also prove unrivaled worldwide.

We are confident that the engineering design methods indicated in this book will come into widespread use and that these fireproof design methods will be seen as an improvement, having as such a greater practicality and reliability than the traditional methods. We are also confident that these design methods will make a significant contribution to further development of building technology.

April 1989

Kunio Kawagoe, Chairman
Comprehensive Fireproof Building Fire Committee

On the Publication of This Book

The Development of Fireproof Building Design Methods in the Construction Ministry's Comprehensive Technology Development Project was promoted for five years from 1982 to 1986 and was completed after it had achieved its purpose in March 1987.

This Project was conceived so that methods for scientifically evaluating safety design could be developed and so that design could be carried out by freely combining a variety of fire-prevention measures within a range which ensured a fixed standard of safety. The Project was also conceived since present-day fireproof design is carried out amidst detailed specification-type legislative regulations and since it has been pointed out that it is difficult for designers to use their own concepts with any degree of freedom for designs and for spatial compositions.

The safety of buildings with designs which are not in strict conformity with the general regulations of the Building Standards Law has already been studied from a variety of perspectives based on Article 38 of said law and the way has been cleared for realizing these with the special approval of the Construction Minister. Nevertheless, these new fireproof design methods do not merely involve approval under Article 38. They are, in addition, tools which are useful for ensuring safety in designing present-day buildings which are becoming larger in scale and more complex in function and for substantiating that safety. We would like these results to be used by the widest possible audience so that they might aid in the development of new technology and improve the safety thereof. The corpus of design methods developed here has been compiled so that these methods will be readily understandable to engineers and have ultimately been published in the form of a book. We are indebted to those committee members in the Construction Ministry and the Construction Ministry's Architectural Research Institute who are in a position to give guidance in the development of these methods for their help in setting up editorial committees and taking part in the writing and editing of this book. Although there were very few persons who took part in the actual compilation of this book, the results are the fruit of the cooperation of more than 200 people who were involved in developing the design methods. As one who guided the project along and oversaw the book as it was being put together, I would like to again thank those involved for their hard work.

The concepts surrounding the forecasting of the fire characteristics and the evaluation criteria for these are at the heart of these comprehensive fireproof design methods. The evaluation system can thus be broadly divided and composed of the following subsystems:

Preventing outbreak of fire and preventing fire from spreading
Smoke control
Evacuation
Fireproof design

Smoke control and evacuation have a particularly strong interrelationship with respect to ensuring safety, these two have been developed as one theme for the sake of convenience. As a result, the details of these have been indicated respectively in Volumes 2 through 4 with "Preventing Outbreak and Spread of Fire", "Smoke Control · Evacuation Safety" and "Fireproof Design" as a subsystem making up the comprehensive fireproof design methods.

The book also includes fireproof design methods for housing. It must first be explained why the theme of fireproof design methods for housing---a section completely different from the three design methods (or evaluation methods) indicated above--makes its appearance. The comprehensive fireproof design methods were originally developed so that they could be applied to all buildings in general. Housing is no exception to this. Nevertheless, housing has characteristics which are different from other buildings on the following points:

1. Housing is made up of single units of small spaces of at most approximately 70 to 200 m^2. As a result, forecasting the fire characteristics of these small spaces and the conditions for ensuring safety for these spaces involves a great many uncertain elements. Although these cannot be quantified using significant methods, these types of small spaces in general buildings are not evaluated very often.

2. Smoke flow, evacuation and preventing fire from spreading throughout the entire building are the most basic types of evaluation made in general buildings. These types of evaluation are very rarely made for housing which was built with common parts left open. This is also true of concentrated housing.

3. Since housing accounts for the vast majority of buildings which make up urban areas, particular attention is required for damage caused by spreading fire from the point of view of urban disaster prevention.

Concepts and design methods are required which are unique to housing on these points.

Another theme is that of fireproof diagnosis and refurbishing. Evaluation is made here by basically applying these comprehensive fireproof design methods for existing buildings. However, comprehensive fireproof design methods are for buildings which are to be designed in the future whereas in this case, preexisting buildings are the candidates. Since the "actual situation" for a variety of conditions (configuration of building, use, method of management, amount of combustible materials stored and the like) must be taken into consideration when making an evaluation, there are a great many restrictions and there are some slight differences in thinking in that there may be more realistic responses.

Volume 1 arranges Diagnosis · Refurbishing and Fire-Prevention for Housing into Part 2 and Part 3. Part 1 is taken up with an explanation of the framework of the overall Comprehensive Fireproof Design Methods. Part 1 consists of an overview of the background and needs of the development of comprehensive fireproof design methods and an overview of the comprehensive fireproof design methods. Part 1 helps to understand just what fireproof design is and also serves as a guide to each of the subsystems. Once the reader has a basic understanding of Part 1 of Volume 1, he or she will most likely be able to open up to any page of any volume if necessary and not be at a loss.

Fire in buildings acts as an external force and its characteristics are many and varied. The human response plays an extremely important role in ensuring safety in such cases. What is more, the relative importance of equipment and devices is significant. It cannot be denied that they are effective against fire in its many forms and involve many elements such as the problem of reliability which are difficult to evaluate. In these comprehensive fireproof design methods, evaluation methods have been developed within parameters which can be quantified scientifically. However, these alone can not clarify all of the safety

factors for fire in buildings. Nevertheless, it can be said that it is now possible to quantify the most basic parts needed to confirm safety. Comprehensive evaluation has been carried out from an even broader point of view to include a qualitative aspect based on these results. Opening the way for designing a truly safe building, even if a method is used which does not strictly conform to current legislation, is a significant result of this.

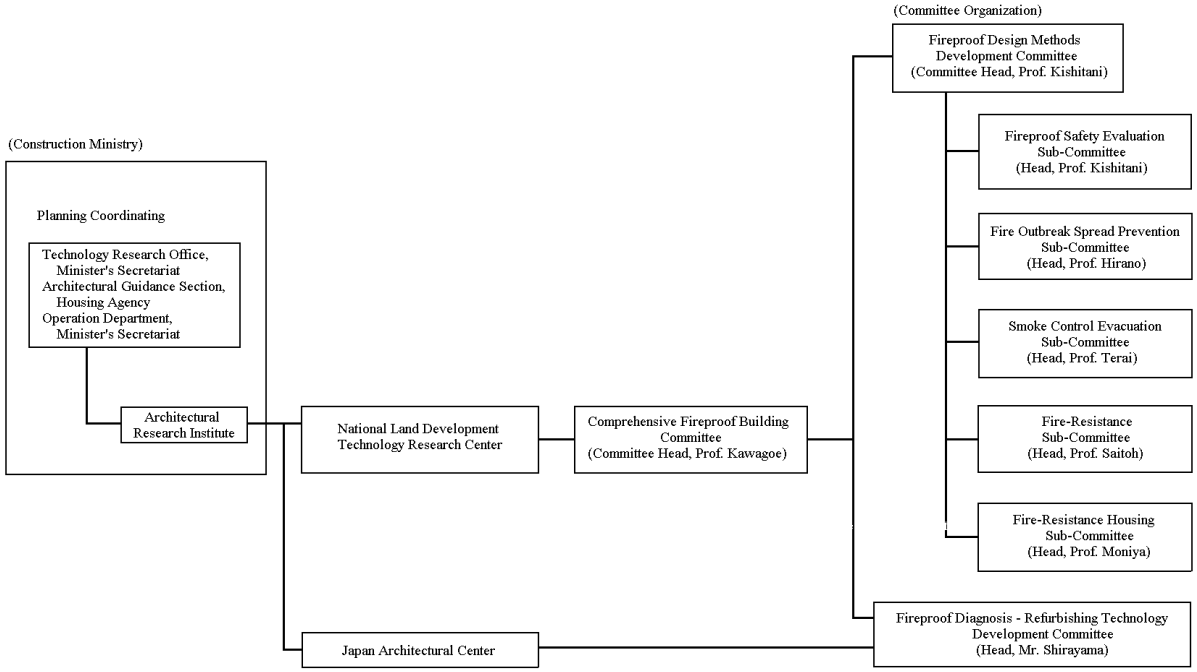
There are still many aspects which are yet to be developed as the fruit of this five-year project. Nevertheless, I should like to receive criticisms and feedback from a wide segment of the public so that I may bring this work to a higher level of completeness. Be that as it may, there are many avenues for using the work effectively at present. Based on this, it is my wish that the development of new buildings and new technologies reach an even higher level.

April 1989
Koichi Kishitani

Chairman, "Comprehensive Fireproof Building Design Methods" Editorial Committee
Comprehensive Technology Development Project

On the "Development of Fireproof Building Design Methods"

This Comprehensive Technology Development Project was started in 1982 by the Construction Ministry's Architectural Research Institute in response to a great number of proposals for building design which used the new design configurations and design technologies of recent years. It called for rational evaluations of these proposals both by administrators and by people who worked in the field. It could be planned due to a confluence of two conditions. First, there was a greater need for increased use of successful design. Second, a considerable amount of fire-prevention research had been amassed by the Construction Ministry's Architectural Research Institute as well as by academic and private-sector research institutions. The Project was promoted by dividing it into two themes: development of an overall system and development of methods of forecasting fire characteristics and evaluation criteria into their respective subsystems, as will be indicated subsequently. The Project was steered in the proper direction by the relevant departments of the Construction Ministry and the Construction Ministry's Architectural Research Institute and the Comprehensive Fireproof Building Committee (Chairman: Kunio Kawagoe, Professor, Tokyo Institute of Technology). The progressive management and overall consolidation of the actual research and development was carried out by the Fireproof Design Methods Development Committee (Chairman, Koichi Kishitani, Professor, Tokyo University) for fireproof design method development and the Fireproof Diagnosis · Refurbishing Technology Development Committee (Chairman, Kazuhisa Shirayama, Professor, Tsukuba University). The overall organization, overview of the progress made during the five-year period and a roster of the members of the Comprehensive Fireproof Building Committee are indicated as follows.



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Secretary Assignee	Kamemura Yukiyasu, Deputy Secretary, National Land Development Technology Research Center

(Persons who left their post during their incumbency)

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Secretary Assignee	Saitoh Sakaaki, Deputy Secretary, National Land Development Technology Research Center
Secretary Assignee	Satoh Hironobu, Deputy Secretary, National Land Development Technology Research Center

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Member	Moriya Hideo, Professor, Engineering Department, Chiba University
Member	Hirano Toshitaka, Professor, Engineering Department, Tokyo University
Member	Terai Toshio, Professor, Engineering Department, Kyoto University
Member	Saitoh Mitsuru, Professor, Engineering Department, Chiba University
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Special Member	Nakamura Kenichi, Head, Fireproof Materials Research Office, 5th Research Department, Architectural Research Institute, Construction Ministry

Special Member	Hasemi Yuji, Head, Fire-Prevention Research Office, 5th Research Department, Architectural Research Institute, Construction Ministry
Special Member	Yamana Toshio, Researcher, Fireproof Materials Research Office, 5th Research Department, Architectural Research Institute, Construction Ministry
Special Member	Matsushita Toshiyuki, Researcher, Smoke Prevention Research Office, 5th Research Department, Architectural Research Institute, Construction Ministry
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Special Member	Yoshida Masayoshi, Department Head, Japan Architectural Center
Special Member	Murakami Hiroshi, Section Head, Japan Architectural Center
Secretary	Hidejima Akinori, Secretary, National Land Development Technology Research Center

Execution Plan

Research Topic		Main Research Themes By Year				
General Name	**Specific Name**	**1982**	**1983**	**1984**	**1985**	**1986**
I. Fireproof Building Design Law Development	1. Development of Comprehensive Fireproof Design Methods	Study Framework for Comprehensive Fireproof Design Methods	Study Comprehensive Fireproof Safety Evaluation Methods	Create Comprehensive Fireproof Design Methods	Create Comprehensive Fireproof Design Method Plans	Consolidate Comprehensive Fireproof Design Methods
	(Development of Fireproof Housing Design Methods)		Understand Problems of Housing Fire Research and Fireproof Housing	Study Fireproof Housing Safety Evaluation Methods	Create Fireproof Housing Design Method Plans	Consolidate Fireproof Housing Design Methods
	2. Develop Fire Spread Prevention Design Methods	Study framework for Fire Spread Prevention Design Methods Document Research	Create framework for Fire Spread Prevention Design Methods	Develop Fire Spread Model	Create Fire Spread Forecasting Method and Evaluation Methods	Consolidate Fire Spread Prevention Design Methods
	3. Develop Smoke Control Evacuation Design Methods	Study framework of Smoke Control Evacuation Design Methods Document Research	Create framework for Smoke Control Evacuation Design Methods	Study Method of Forecasting and Calculating Smoke Control Effect / Evacuation	Create Smoke Control Evacuation Forecasting Model and Evaluation Methods	Consolidate Smoke Control / Evacuation Design Methods
	4. Develop Fire-Resistant Design Methods	Study framework for Fire-Resistant Design Methods Document Research	Create framework for Fire-Resistant Design Methods	Study Forecasting Model for Fire Characteristics at Peak and Structural Behavior	Create Fire-Resistance Forecasting Methods and Evaluation Methods	Consolidate Fire-Resistant Design Methods
II. Dev. of Fireproof Diagnosis Refurbishing Technology for Existing Buildings	1. Develop Fireproof Performance Diagnostic Methods	Study framework for Fireproof Performance Diagnosis Methods-/Document Research	Study Actual Situation of Fireproof Maintenance and Management	Study Fireproof Performance Diagnosis Technology	Create Fireproof Performance Diagnosis Methods Draft Plan	Consolidate Fireproof Performance Diagnosis Methods
	2. Develop Fireproof Refurbishing Technology		Create Fireproof Refurbishing Technology framework	Study Fireproof Refurbishing Technology	Create Fireproof Refurbishing Model	Consolidate Fireproof Refurbishing Technologies

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